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Water Hyacinth Communities and Succession in Florida

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ABSTRACT

Quantitative mesofaunal collections were made at the Fisheating Creek cypress swamp, Highlands County, Florida, from water hyacinth in a temporary pond situation. Comparison to channel water hyacinth revealed that animal communities inhabiting pond hyacinth differ. Data showed a horizontal successional pattern through open water, floating, transitional, and terrestrial hyacinth zones. Examination of vertical stratification indicated the presence of characteristic taxa in subpatomic, floor, and herbaceous strata. The role of hyacinth and hyacinth peat in temporary pond areas and its biological value to the surrounding communities are discussed.

Descriptors: Water hyacinth *(Eichhornia crassipes),* quantitative ecology, invertebrates, faunal succession, subtropical Florida, stratification.

INTRODUCTION

Water hyacinth *(Eichhornia crassipes* Mart.) is a controversial plant with a long history of worldwide introduction into tropical and temperate waterways. This ubiquitous freshwater flower can be found coastally worldwide between latitudes 45° N and 45° S, owing much of its success to its ability to reproduce both by seed and vegetatively, produce new plantlets in nine to fifteen days, and regenerate from cut pieces (Das, 1969). Klorer (1909) noted its 1884 presence at the New Orleans Cotton Centennial, claiming that secondary invasion of Florida had taken place by 1890, but Goin (1943) makes a case for Floridian introduction as early as 1835. Penfound and Earle (1948), Vietmeyer (1975), and Queijo (1977) review its economic impact, ecology, and control, citing an annual

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worldwide loss of five million dollars traceable to interference with drainage, light penetration, navigation, wildlife, and recreation. Water hyacinth's effects on various forms of wildlife have also been studied by Barber and Haynes (1925) and Lynch et al. (1947).

Recent work has increasingly approached the water hyacinth "problem" from a less negative viewpoint, concentrating on total ecology and noting a variety of positive aspects. Water hyacinth has been shown to remove excess nutrients from water making itself useful in effluent purification from sewage plants (Jagadeesh and Lakshminarayana, 1971), and to serve as a natural fertilizer, animal food, and a source of several chemicals (Sharma, 1971; Queijo, 1977). O'Hara (1967) quantitatively studied water hyacinth fauna in canals stressing the high numbers of invertebrates inhabiting the mats. He found a predominance of snails and the amphipod, *Hyalella azteca,* an important consumer of water hyacinth and prey of sunfish (Hansen et al., 1971). Similar studies of floating plants and their associated fauna have been carried out on duckweed (Scotland, 1934) and on the water ferns *Azolla* and *Salvinia* in Argentine lagoons (Ronderos et al., 1965, 1967, 1968, 1969; Schnack, 1970, 1971, 1972).

A Carthage College field ecology class carried out quantitative research on a water hyacinth population in a shallow cypress swamp/temporary pond to learn ecological methods. This report presents the results of that work.

METHODS

The study site was the Fisheating Creek cypress swamp, near Venus, Highlands County, Florida. The surrounding cypress-bay floodplain is an extension of the northern fringe of the Big Cypress Swamp, and lies just southwest of the southern tip of the Highlands Ridge. Preliminary sampling early in January, 1975, using techniques outlined by Suter (1966), led to quantitative collections from 20-21 January 1975. For these collections, different areas of the site were categorized as open water, floating hyacinth in shallow water, transitional zone half-floating and half on the wet peaty shore, and hyacinth mat on shore (Figure 1). Within each zone, three separate strata were designated: 1) herbaceous (green leaves and floatants above the water or floor line), 2) floor, and 3) subpatomic (beneath "floor") root mat and its substrate. The fauna in each of the zones and strata were sampled, using manual, Berlese, and seine techniques. Manual collections were made in five square meters of area in each zone by separating the strata within a quadrat, quickly bagging this material, and then carefully sorting through it to collect macroscopic fauna. A foundry riddle was also used as a shaker/sifter over a white plastic sheet to separate the animals from their substrate. Berlese samples of each semi-dry stratum and zone were extracted using the Tullgren modification of the Berlese funnel (Peterson, 1959). In open water,

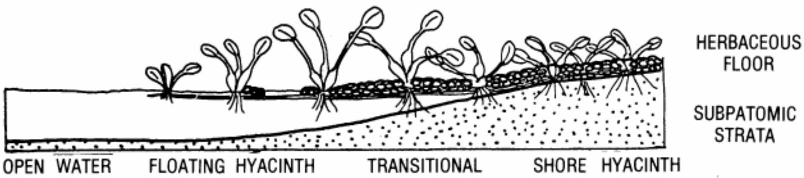

Figure 1. Schematic Section Showing Zones and Strata

after collecting the five manual quadrats, using a dip net and porcelain pan, the water was "seined" through a three-square-meter area using a frame-mounted fine mesh screen.

Square meter quadrats were chosen as a unit of sampling equivalency. The size of areas sampled and wet weights of floral material present were recorded for each sample so that manual quadrats, Berlese, and seine samples could be integrated into average square meter tabulations. This technique attempts to standardize the amount of habitat sampled to allow comparison of the relative abundance of species between different zones and strata. In each quadrat, the per cent free water present in various samples was calculated by comparing initial wet weight with the dry weight after one week in drying apparatus. After all faunal collections were sorted, counted, and identified, data were tabulated according to zonation and strata to demonstrate the relationship of faunal shifts to habitat succession.

RESULTS AND DISCUSSION

Water hyacinth can prosper in a variety of ecological situations. Although considered an aquatic weed, it is capable of establishing rooted populations on land. Penfound and Earle (1948) reported that hyacinth's insulating adaptations enable it to live through frosts in the New Orleans area and to resist extreme exposure and summer heat. We have observed hyacinth thriving in various light intensities from deep shade in swamps through bright conditions on the sandy shores of Lake Okeechobee.

Although water hyacinth in these diverse communities seems to be very similar, the fauna associated with each community appear to vary. Our data show that the fauna of pond hyacinth is strikingly different from that reported by O'Hara (1967) for channel hyacinth. Average square meter totals are slightly higher in O'Hara's study; he reports 16,484 animals per square meter, compared to our totals, ranging from 276.6 in open water to 11,091.6 on the shore. The animal composition in his study was 28% snails, 33% scuds, with beetles and water bugs both noted as uncommon. **In** our study snails were very uncommon, and scuds never exceeded 25% (They represented less than one per cent of the collection in the floating hyacinth zone which should have been most like the

community he studied). Water bugs accounted for about 5% of our total animals, but beetles were very abundant, reaching a peak of well over 50% of the individuals reported for the floating hyacinth zone. Pennak (1953) noted that many water beetles avoid currents, however slight, which helps to explain this anomaly.

Many relatively abundant species in our data were cited by Arnett (1960), Jaques (1947), Kaston (1953), or Pennak (1953) as typical swamp or marsh species, frequenting shorelines with abundant vegetation. Examples of these types include the aquatic snails, pisaurid and lycosid (especially *Pirata sp.)* spiders, veliid and hydrometrid bugs, and beetles, such as the smaller hydrophilids *(Enochrus* and *Paracymus),* tachyine ground beetles *(Paratachys* and *Elaphropus)* and *Stenus* of the staphylinids. These species were flexible enough to tolerate the full range of conditions in our study, venturing into open water.

Ants were also present throughout the hyacinth mat, even though this group was generally better adapted to drier conditions. It appeared that they simply went where the food was. Moreover, water hyacinth served as an excellent refugium during the dry season for a variety of prey animals. Such refugia may amass large totals of individuals when surrounding habitats dry out. Over 2,000 ants per square meter of shore hyacinth may be found under these conditions.

SUCCESSION

Categorizing successional schemes presents the difficult challenge of attempting to subdivide a process which is itself continuous. This situation particularly applied to water hyacinth on temporary pond edges, since the water rises and falls, disappearing entirely at the height of the dry season and obliterating distinctions between the stages. Therefore, although these stages clearly show a measurable shift in amount of organic matter, animal populations, and water depth and drying of the habitat (Table 1), dividing this continuum into stages and collecting fauna from these is by necessity arbitrary. Since the transitional zone shifts as the water level rises and falls, specific faunal ties cannot be expected. Nevertheless, many faunal elements do characterize certain successional stages (Table 2). Some of these indices can be

Table 1. Characteristics of different zones

	Open Water	Floating Hyacinth	Transitional	Shore Hyacinth
Water depth (centimeters)	9.6	7.8	1.4	0
Per cent free water, subterranean	100	100	100?	25
Per cent free water, floor & roots	100	89	80	69
Per cent free water, herbaceous	(100)	88	93	81
Total number of species	46	127	166	174
Total number of individuals	276.6	7172.9	5473.7	11091.6

Table 2. Faunal succession, average numbers of selected species in each stage

Component taxon	Individuals per average square meter: Open Water	Floating Hyacinth	Transitional	Shore Hyacinth
Corixidae: *Sigara* (water boatmen)	10.5	0	0	0
Gyrinidae: *Dineutus* (whirligig beetle)	7.4	0	0	0
Cyclopidae (copepod microcrustacea)	72.6	1.9	0	0
Baetidae naiads (immature mayflies)	64.2	9.5	0	0
Astacidae (crayfishes)	24.4	5.2	0	0
Hydrophilidae: *Tropisternus* (water scavenger beetles)	4.9	1.9	0.2	0
Talitridae: *Hyalella azteca* (scud)	67.3	47.5	24.2	0
Dytiscidae: *Brachyvatus apicatus*	1.2	473.7	32.4	0
Laccophilus	2.3	223.1	1.0	0
Noteridae (burrowing water beetles)	0.3	3000.8	4.0	0
Naucoridae (creeping water bugs)	0.7	44.9	0.2	0
Ceratopogonidae (biting midges)	0.2	42.8	0.2	0
Hydrophilidae: *Hydrochus*	0.6	21.5	0.2	0
Erpobdellidae (leeches)	0	24.0	0.2	0
Hydraenidae: *Hydraena marginicollis* (minute moss beetles)	0	649.5	71.2	0
Belostomatidae (water bugs)	0	24.4	1.0	0
Dytiscidae: *Desmopachria grana*	0	65.5	1.6	0
Hydrovatus	0	68.2	0.6	0
Mesoveliidae: *Mesovelia*	0	1.3	25.8	5.6
Scydmaenidae: *Euconnus clavipes*	0	0.2	10.9	0.4
Carabidae: *Clivina*	0	0.6	21.2	0.8
Sminthuridae (springtails)	0.4	0	1339.1	41.5
Myrmecine ants	0.2	65.3	61.7	2044.2
Chalcidae (microwasps)	0	0.6	10.4	36.2
Pselaphidae: *Reichenbachia*	0	1.9	27.4	38.8
Bibloplectus	0	0	10.1	36.2
Carabidae: *Paratachys*	0	2.0	25.7	37.0
Ptiliidae: *Acratrichis* (featherwing beetles)	0	0.4	1.6	92.8
Bambara (featherwing beetles)	0	0	10.1	120.3
Pteryx (featherwing beetles)	0	0	0	175.5
Dryopidae: *Pelonomus gracilis* (long-toed water beetles)	0	0.4	53.2	762.2
Lygaeidae (plant bugs)	0	0	2.2	50.3
Curculionidae: *Sphenophorus* (weevils)	0	0	0.2	1.4
Chilopoda (centipedes)	0	0	0	15.0
Lonchopteridae (pointed wing flies)	0	0	0	80.1
Zonitidae (land snails)	0	0	0	17.7

explained by some physical feature of the environment, food preferences, or microclimatic differences between stages. For example, open water species often need and utilize light to capture their prey (Cyclopidae, Baetidae, and Corixidae), and expanses of open water are sometimes required for effective swimming (Gyrinidae and larger species of Hydrophilidae and Dytiscidae).

The animals in the floating mat are interesting species, often representing near-relative species of the truly aquatic animals in open water. These species adapted to crawling or burrowing through wet vegetation instead of swimming. In comparison with more aquatic types, such developments apparently involved a variety of morphological changes, including less streamlining, smaller size, less modification of appendages for swimming, and a much slower gait. Leeches utilize this stage to seek their vertebrate hosts which may either be present in the nearby water or use the hyacinth as a dry season refuge.

The transitional zone showed few clear biotic indices, possibly because it is relatively narrow and unstable. The most characteristic animals were the minute water treaders, which feed through the surface film on plankton concentrated along the shoreline: two species of beetles, *Euconnus* (Scydmaenidae) and *Clivina* (Carabidae) likely predators of land species; and the Sminthuridae, potential prey of the beetles and probable consumers of hyacinth and developing fungal hyphae. As might be expected, a number of terrestrial species present in this stage show a dramatic increase in population size which continues into the shore zone.

The amount of organic material in the floor stratum also increases in transition to the shore zone. On shore it becomes drier, furnishing a direct food supply for scavengers (Zonitidae) and a substrate for fungi eaten by Ptiliidae and sarcoptiform mites. The relatively thick peat also acts as an aestivaculum for land species nonresistant to drought and a breeding and incubation site for immature land insects, which are generally weakly sclerotized and subject to drying. These species, in turn, attract large numbers of parasitic microwasps (Table 3).

Table 3. Numbers of immature insects and microwasps per average square meter in each zone.

	Open Water	Floating	Transitional	Shore
Naiads (aquatic immatures)	65.1	11.6	0.2	0
Nymphs	0.2	65.9	52.6	1.4
Caterpillars	0	0.6	22.2	1.0
Beetle larvae	2.2	23.2	44.8	805.7
Fly larvae	2.8	48.1	86.6	185.6
Microwasps (parasitic)	0	0.6	10.4	185.9

STRATIFICATION

Vertical stratification of the fauna was not as clear as the horizontal faunal shifts from zone to zone. Aquatic mobility of many species often precluded attempts to make distinctions in the subpatomic aquatic stratum. For example, whirligig beetles are highly adapted for life in the water surface and retreat to deeper water when disturbed

One subterranean terrestrial index present in the collections was a distant earthworm relative lacking pigmentation. These were relatively uncommon because of the rapid transition from saturated to relatively dry soils in our study area.

The floor stratum had several litter scavengers (earthworms and psychodid fly larvae) and their predators (clubionid spiders and the ground beetle *Clivina)* restricted to it. One peculiar genus of predaceous diving beetles, *Hydrovatus*, also abounded in the root mat of the floating hyacinth zone.

The herbaceous stratum had the greatest number of index species in our study. These types were nearly equally divided between plant feeders utilizing the water hyacinth directly (aphids, cicadellid leaf hoppers, and caterpillars) and their predators which may stay in the herbaceous stratum because of a lack of swimming ability (lady-bird beetles, jumping spiders, and *Euconnus* of the Scydmaenidae).

CONCLUSION

This study outlined a faunal successional pattern through several stages of water hyacinth habitat. The habitat furnished by the water hyacinth and its associated peat becomes especially important during the dry season when it serves as a sponge-like refugium for invertebrates which would otherwise perish. Hyacinth is the structural foundation of a complex community which potentially has many benefits. The teeming arthropod populations may very well promote fisheries and other aquatic life.

It appears that water hyacinth will continue to thrive in Florida, insured by its resistance to drought and cold and through big reproductive potentials. Some controls on this growth are necessary to keep it from interfering with irrigation, navigation, and recreation, but care must be taken to moderate such management by evaluating total environmental impact. Water hyacinth has significant ecological importance in Florida. It can be viewed as a resource whose role and potential should be carefully studied so that it can be wisely used.

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